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CENTRAL INTELLIGENCE AGENCY

INFORMATION REPORT

REPORT [redacted]

50X1-HUM

COUNTRY : USSR/Germany (Sov Zone)

SUBJECT : Soviet and German Measuring Instruments

[redacted]

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(LISTED BELOW)

SUPPLEMENT TO
REPORT NO.

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THIS IS UNEVALUATED INFORMATION

[redacted]

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General

1. By 1951 all the standard measuring instruments for temperature, pressure, density, volume and electricity were available in the USSR. A great shortage of high precision instruments, however, continued to exist. These cannot be made either in the USSR or in the Soviet Zone of Germany. [redacted] Some instruments were also made in the USSR [redacted] patent licenses. After World War II the Soviets collected German instruments by the carload from East German instrument plants and from the various East German industrial and technical installations. Many of these instruments were distributed in a more or less haphazard way to Soviet plants and research institutes without regard for individual requirements. At the GIPKh Institute, for example, [redacted] 10 hygrometers, while the whole Leuna Plant had never used more than two. As late

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[redacted] In the post-war period the Soviets continued to make their own standard instruments on foreign patents, but their quality was generally inferior to that of the prewar instruments, partly because of shortage of materials, and largely because of improper assembly by poorly trained technical personnel. The Soviets are putting special emphasis on the development of electronic instruments and in this particular field they seem to be rather ahead of the Germans.

Conventional Instruments

2. [redacted] a list of all the main instruments used in large chemical plants in Germany. [redacted] the Soviets had at least one of each of these instruments. [redacted]ther they were actually in use. A list similar to the one [redacted] prepared for the Soviets is given in Enclosure (A). [redacted]

"Special" Instruments

3. Aside from the conventional instruments used, [redacted] three special instruments [redacted] The first two were used at the GIPKh Institute in Leningrad, the third in the Soviet-sponsored laboratory at Leuna.

a. Electronic instrument for chemical analyses [see Enclosure (C) Sketch 1]:

The milliammeter or millivoltmeter of this instrument had a piece of aluminum foil attached to the indicator needle in such a manner that it passed between two condenser plates when the needle moved. The current resulting from the change in capacitance is first amplified by a vacuum tube and then used to operate a relay switch. The instrument is sensitive to a change of 0.2-0.3 millivolts, and the condenser plates can be adjusted for minimum, normal or maximum swing of the needle. The instrument operates with very little delay and is especially good for use in chemical analyses where, for example, the rapid closing of a valve may be necessary to prevent an explosion due to excess oxygen. Since there is no friction when the aluminum foil moves into the electrostatic field of the condenser, the instrument requires little repair. Its defects are that it is a low resistance instrument and the magnets are not of uniform strength.

b. An infra-red device for the measurement of the carbon dioxide content of a gas [see Enclosure (C) Sketch 2]:

The gas to be analyzed is blown through the analyzer column, while a gas containing no carbon dioxide, such as nitrogen, is blown through the comparison column. Infra-red radiations pass down through the gas in these columns into the measuring chambers beneath. These measuring chambers are filled with pure carbon dioxide (the gas to be determined in the test sample). Since some of these radiations are absorbed by the carbon dioxide in

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the analyzer column, and none by the gas in the comparison column, the temperature will be higher in the measuring chamber beneath the comparison column. This temperature difference in the measuring chambers causes a resultant pressure differential which in turn produces a change in the capacity of the membrane condenser connected between these chambers. The radiations are interrupted by a moving shutter, and the resulting variations in temperature and pressure cause an alternating voltage to be imposed on the direct voltage of the condenser. This alternating voltage is rectified, amplified, and read directly on a voltmeter which is calibrated in percentage of carbon dioxide.

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Defects and Shortages

4. The Soviets do not make high grade precision instruments, nor are they made in the Soviet Zone of Germany. For practical purposes, the Soviet Zone can now be considered as part of the USSR, and shortages in the one area are likely to be reflected in the other. The measuring instruments [redacted] in Leningrad were nearly all taken from Leuna. [redacted] some which had been manufactured in the East Zone and also some Soviet-made instruments. The older Soviet instruments, made under US patents, were fair in quality. The newer Soviet instruments, made mostly in Plant 288 at Leningrad, were generally of rather low quality when compared to the instruments used at Leuna. The latter were made exclusively by Hartmann and Braun AG, Frankfurt a M, or produced at Leuna. The main reasons for the quality of the instruments available to the Soviets can be summarized as follows:

a. Scarcity of competent craftsmen: The Soviet scientific and technical personnel are well-versed in scientific theory, but there is a great scarcity of skilled craftsmen to do the actual work. In the Institute [redacted] frequent trouble in mounting instruments, either because the individual parts were assembled wrong, or because they did not fit properly. In the Soviet factories women workers were utilized who frequently had no technical training or any knowledge of the principles necessary to do first-class work. Even where good measuring instruments are available, a most difficult problem remains in making the proper connections to the main switchboard, which may be hundreds of feet away from the instrument itself. In large chemical plants like Leuna where connections have been added over a period of many years, the problems of this nature have a very direct effect on the production. There are certain delicate tasks that neither the Soviets, nor even the Germans of the East Zone can perform. For example, instruments which require the soldering of gold bands, as small as 0.01-0.02 mm thick and placed 1 mm apart to serve as electrical conductors attached to moving coils, can be supplied only by Hartmann and Braun in Frankfurt. The Soviet training in electronics, however, is better than it was in Germany. For example, 15% of the workmen at GIPKh were able to repair an oscillograph, while none at the Leuna Plant were able to do this repair work.

b. Inability to produce instruments having a high Ohm resistance: Most Soviet measuring instruments operate on low Ohm resistance (from 50 to 200 Ohms), since the Soviet Zone cannot produce instruments with more than 200-300 Ohm resistance. The result is that the end variation in Soviet instruments is around one or even two percent, whereas high grade German instruments used in advanced research, have only a 0.2% variation. If, for example, an instrument of 100 Ohm resistance is connected with a thermo-element of nickel, one may have a one percent variation, or one millivolt, on a scale of 100 millivolts. That means about a 40 degree error in the temperature being measured.

c. Low quality of thermo-couples: [redacted] at Leuna in the summer of 1951 [redacted] there was great difficulty in procuring the right kind of wire for conductor wires or thermo-couples. Formerly I G Farben required a precision of 0.1 percent variation from the value recorded by the use of a standard wire. For large-scale production it is absolutely necessary to always have exactly the same wire, or the whole production will become non-uniform due

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to incorrect temperatures. The problem of uniform wire is quite serious when it is remembered that some hundred furnaces may be producing at the same time, or when you consider the fact that over the years thousands of meters of wire have been added and that the temperature measurements are based on a fixed quality of wire. Good wiring material used to come to Leuna from a factory in Herne, Westphalia, in the British Zone of Germany. Now that this material is no longer obtainable, the Leuna people have to resort to makeshift solutions. They have to fall back on the use of wire furnished by a factory in Hettstedt, near Halle. This plant used to make only copper wire, but may, in time, be able to produce nickel wire. There is no factory in the Soviet Zone which can make wire that varies less than 1.5 percent from the old standard wire used for thermo-couples. The Leuna people were also forced to take old, but good, quality lead wire, remove the insulation, and use the wire for the thermo-couples in the furnace, while new wire of poor quality was used to connect the thermo-couples to the measuring instruments. In this way Leuna hoped to be able to carry on for about one year on their reserve wire. After that a crisis will develop unless the proper nickel-chrome wire can be procured. In the USSR the wire used for thermo-couples is not very good either and only reaches a precision of 0.5% minimum variation from the standard. The advantage of this wire over that made in the Soviet Zone is that it is more or less constant.

d. Inability to produce small, resistance thermometers: Resistance thermometers, capable of measuring temperatures from minus 200 to plus 500°C are used in chemical processes. It is naturally desirable to make them as small as possible so as to measure the temperature of liquids or gases in one particular spot. They are usually constructed having a standard 100 Ohm resistance measured at 0°C. For best results they are made of 0.05 mm platinum wire which is not available in the Soviet Zone. Leuna used to get this wire from the Heraeus firm, located at Hanau near Frankfurt a M. Leuna still has some stocks of platinum wire, [redacted] On the other hand, good resistance thermometers are very small, about the size of a match, and can easily be smuggled across the border. To relieve the shortage of resistance thermometers, the Soviet Zone has begun winding them on mica (Glimmer), but here again, the absence of small platinum wire leads to the making of larger thermometers, since the Ohm resistance of an instrument must always be the same and more of a larger wire is required to give a certain resistance. In the USSR resistance thermometers are about as large as pencils, [redacted] 50X1-HUM (The Soviets make many other kinds of thermometers, such as the Foxboro type using nitrogen gas, ether, petroleum, mercury, etc, as the expanding agents. They also make glass thermometers of all sizes and shapes.)

e. Shortage of good springs and bearings: No steel springs for instruments are made in the USSR. They do make bronze (Rotguss) coil springs, but these contain copper and zinc, and are not resistant to ammonia and other chemicals, and hence are of limited use only. At Leuna [redacted] the Soviets were planning steel spring production, [redacted] the machine and measuring instruments plant of Schaeffer and Budenberg, SAG, Magdeburg, would be the logical place. Most of the Soviet instruments, like the German, have moving coils which are attached to an axis, supported by agate bearings.

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At the GIPKh Institute [redacted] a package of such bearings which must have come from [redacted] Germany (the writing on the package was not in Russian characters, at any rate!). [redacted] nearly all German stone bearings were cut in Idar-Oberstein, northeast of Kaiserslautern. The Hartmann and Braun instrument plant used to get their bearing stones from Idar-Oberstein. Bitterfeld, in the Soviet Zone, made synthetic bearing stones by means of an electric arc, but they too were sent to Idar-Oberstein for cutting. [redacted] not [redacted] any synthetic bearing stones, or plant for cutting such stones, in the USSR, nor [redacted] the source of the bearing stones which are now used in the USSR. [redacted] they are probably securing them from Bitterfeld.

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Procurement and Repair

4. [redacted] the GIPKh Institute [redacted] about 70 percent of the instruments available were from dismantled factories in the Soviet Zone, 25 percent were of US origin, and 5 percent were of Soviet manufacture. Later, the same percentages applied, but the German instruments were of new manufacture, having been produced by the various Soviet-controlled instrument plants at Magdeburg, Chemnitz and Quedlinburg. (Most of the former Soviet-controlled firms, SAG, incidentally, are now referred to by a new name; for example, "Staatliche Geraetebau AG, Magdeburg"--State Instrument Manufacturer. This indicates that they are state-owned, but does not specify whether "state" refers to the DDR or the USSR!) 50X1-HUM

5. On the older instruments the lettering on the name plates was usually in Latin or English characters; on the new ones, even when they came from German factories, the lettering was in Russian. [redacted] for instance, the name plate on a galvanometer which bore the inscription "Pokazovich Galvanometer Utikelen, Geretebau Magdeburg" (Recording galvanometer, built-in), all in Russian letters. The Russian letters were also used to express international units such as volts, amperes, watts, etc, but the name plates never contained any plant name or serial numbers, except the plant number, such as "Zavod 288", which referred to an instrument plant in Leningrad. 50X1-HUM

6. Periodically the scientists at the GIPKh Institute were questioned concerning their needs in regard to instruments. This applied only to standard instruments, as none were made to our special order. [redacted] they were all delivered from Moscow. There was normally about a six-month delay from the date of the order, even though the GIPKh was a government institute, and as such had some priority for deliveries. [redacted] 50X1-HUM

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7. The Institute had a quota for repairs, but it took about six months before an instrument which had to be sent out for repairs was returned. The practice of "black market repairs", that is outside of official channels, was strictly prohibited but extremely prevalent. [redacted] 50X1-HUM

[redacted] 50X1-HUM

8. The Soviets have excellent State catalogs for measuring instruments. There is one catalog for each category of instruments, such as thermometers, voltmeters, and pressure gauges. These catalogs are more complete than those we had in Germany. They show more standardized and interchangeable instruments, while the German equivalents showed more instruments with minor differences in size and construction. German firms under Soviet control now build instruments shown in the Soviet catalogs in conformance with the Russian standard. [redacted] seen a Soviet book on instruments which was used extensively at the Institute. It contained a listing and description of all the standard instruments produced by such firms as Foxboro, Siemens, Schaeffer & Budenberg, and others. [redacted] this was mostly a Russian copy or translation of the data contained in the instrument catalogs of these foreign firms.

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-end-

Enclosures:

(A) Measuring Instruments used in Large Chemical Plants

(B) Reproduced Pictures of Instruments used at GIPKh

(C) Sketch 1 Electronic Instrument for Chemical Analyses
Sketch 2 Infra-red Device for Measuring Carbon Dioxide Content of a Gas

(D) Apparatus for Testing Ignition Lag of Rocket Fuels

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MEASURING INSTRUMENTS USED IN LARGE CHEMICAL PLANTS   ENCL. A

I Temperature Meters and Regulators

A. Types:

1. Telethermometer--based on a manometer measuring device for use up to +300°C.

2. Resistance thermometer with Wheatstone bridge circuit and millivoltmeter or electro dynamometer reading (copper, nickel, iron, and platinum resistance wires used). Temperature range from -200°C to +500°C.

3. Thermo-couples as follows:

Iron-constantan	up to 600°C
Copper-constantan	up to 500°C
Nickel-nickelchrome	up to 900°C
Platinum-platinum rhodium	up to 1600°C

The reading is on a millivoltmeter, thermograph, compensation apparatus, or signal instruments.

4. Pyrometer and pyrido-pyrometer

Reading on a millivoltmeter and temperature range from 500° to 3000°C.

5. Tube regulator (expansion principle)

B. Uses:

The instruments enumerated above were used in all large chemical plants with the exception of those requiring special instruments due to danger of explosions as, for example, in plants where hydrogen is used. In these cases manometrical thermometers are used, since they operate without electric impulses. All the above instruments can also be modified to operate as pneumatic or mechanical regulators, and can be furnished with signal or alarm devices.

C. Manufacturers:

Measuring instruments, switchboards, auxiliary devices, etc, for the above instruments 1 through 4 were manufactured and installed by the following firms:

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Mangels	Leipzig
Schellhase & Co (GST)	Berlin
Askania	Berlin
Schaeffer & Budenberg	Magdeburg
Siemens	Berlin

[redacted] 50X1-HUM

Steinle & Hartung	Quedlinburg
IG Farben Plant Control Offices	Hoechst, etc

II Quantity Measuring Instruments and Regulators

A. Types:

1. U-shaped manometers and flowmeters. These were made of glass and operated up to 120 atm pressure (non-recording).

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ENCL, A

2. Level difference indicators. These were made of V2A steel, with magnetic indicator, and operated up to 250 atm (non-recording).

3. Ring manometers--low pressure type up to 6 atm; high pressure type up to 700 atm. They measure liquids (including propane, ammonia, etc), gas, steam, and other chemicals, provided they are not corrosive and do not react explosively with the blocking liquids in the instruments. These blocking liquids may be oil, carbon tetrachloride, water, mercury, etc.

4. Pressure difference recorders:

   a. Direct recording (sealing ring)

   b. Magnetic transmittal

   c. Inductive transmittal

   d. Diaphragms for low pressure

   (a, b, and c can be used up to 350 atm pressure. For liquids flowing 3 l/h or gases flowing 30 l/h, use instruments as under 3 above.)

Regulating shutters, regulating tubes, and venturi tubes are used as throttling devices in conjunction with the above instruments, depending upon the product to be measured. Armatures and connecting lines must be installed carefully and accurately to assure proper measuring control.

5. Other quantity meters.

   a. Piston meters for liquids (app 30 cbm/h; supplied by IC Eckardt, Stuttgart)

   b. Oval wheel meter for liquids (app 100 cbm/h; supplied by Bopp & Reuter)

   c. Woltmann meter for liquids (supplied by Woltmann, Berlin)

   d. Gas meter (supplied by Pintsch, Berlin)

   e. Greefe meter and rota meter (floating lift with inductive transmission; supplied by IG Farben for own manufacture)

   Use of these instruments same as for 3 above.

B. Manufacturers:

IG Farben (for own manufacture)	Hoechst, Leuna, etc
Bopp and Reuter	Mannheim
[redacted]	
Junkers	Dessau
Askania	Berlin

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ENCLOSURE (A)

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ENCL. A.

III Pressure Meters and Regulators

A. Types:

1. Micromanometers from 0-10 mm H_2O (also recording)
2. Manometer with diaphragm or membrane 0-30 kg/cm^2
3. Manometer with Bordon spring, 0 to 1000 kg/cm^2
4. Manometer with IG safety spring, 0 to 2000 kg/cm^2
5. Pressure difference manometer
6. Vacuum manometer

(All above mentioned manometers can be built as instruments for registering, recording, telerecording and signaling, as well as for regulating.)

7. Air controlled manometer (manufactured by IG Farben)
8. Air controlled difference manometers (manufactured by IG Farben)

B. Uses:

The manometers mentioned above can be used for almost all chemical products and gases. If the gases or chemical products are aggressive, intermediate membranes or blocking liquids or V2A armatures must be used.

C. Manufacturers:

Special firms for the production of manometers are:

Askania	Berlin
[redacted]	
Schaeffer and Budenberg	Magdeburg
IG Farben (for own manufacture)	Leuna

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Special firms for the production of vacuum recorders and regulators:

[redacted]	
Askania	Berlin
[redacted]	

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IV High Level Indicators and Regulators

A. Types:

1. Ring manometers using mercury and measuring up to 700 atm pressure or 0 to 5 m of liquid.
2. Pressure difference meters which are automatic, magnetic, and inductive, operating up to 350 atm with a liquid height of 0 to 10 m.

ENCLOSURE (A)

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ENCL A.

3. Float recorder, also automatic, operating up to 25 atm; liquid height of 10 m.

4. Full float recorder with suspended spring (IG patent), and with inductive indication on millivoltmeter reading, with liquid height up to 3 m.

5. Pressure difference meters made of V2A with magnetic transmittal.

6. Pfleiderer tube (for boiler houses)

7. Indicators (stationary) with photocell and inspection glass, operating up to 250 atm.

B. Uses:

All pressure meters can be installed as instruments for registering, alarming, recording and regulating. With corrosive products, the same precautions should be used as mentioned in III B above. These instruments are used to measure the same products as indicated in II A 3 above. For liquid gases, eg, propane, ammonia, etc, the floats should be in the container of the product which is measured, since boiling of the liquid can lead to large errors in measurement.

C. Manufacturers:

Manufacturers of the above instruments are as listed under II B. Most of the pressure meters, however, were manufactured in the Control Shops of the IG Farben plants.

V <u>Analysis Instruments</u>

A. Types, uses, manufacturers:

1. Oxygen measuring instruments and recorders

0-1% and 0-8% O_2 in N_2, H_2, CO_2

The gas sample is passed over a catalyst which causes the oxygen to combine with some other element, and the temperature increase is measured by a thermo-battery (crude measurement).

2. Oxygen, carbon monoxide, and hydrogen measuring instruments and recorders, for gas mixtures containing 0-0.1% O_2 (same as above, except that the heat determination is by a Wheatstone bridge. Sensitive measurement.)

3. Oxygen measuring instrument for mixtures of 0-1% and 0-100% oxygen in almost all gases including acetylene, but not in nitrous oxide. The measuring principle is a magnetic recorder of a Wheatstone bridge (ring chamber method.).

Instruments in 1-3 above have only 20-30 seconds recording delay.

4. Oxygen, carbon dioxide, sulphur dioxide, carbon monoxide, and hydrogen measuring instruments on a mechanical or volumetric basis for measuring mixtures from 0-3% and from 0-100% of these gases. The analysis of these gases is based on their combustion and resulting absorption, then measuring the decrease in volume. These instruments are used in all cases where the speed of recording is not essential, as the recording delay is 2.5 to 3 minutes.

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ENCL. A

5. Hydrogen, carbon dioxide, and sulphur dioxide measuring instruments. From 0-1% and from 0-20% of the above constituents of the gas to be analyzed. These instruments operate on the principle of the heat conductivity of the gas to be analyzed in comparison with that of air. Manufacturing firms are IG Farben, Siemens, Hartmann & Braun, Askania. These instruments are used mainly in boiler houses and for fuming gases, as well as for determining hydrogen in the ammonia synthesis process.

6. Uras gas recorder (infra-red recorder). This is mainly for measuring carbon monoxide in concentrations of 0-0.1%. The measuring principle is based on the absorption of infra-red radiations by carbon monoxide. It is used in almost all technical and synthetic gas analysis and is manufactured by IG Farben, Pollux in Ludwigshafen, and Hartmann & Braun in Frankfurt aM.

7. Density recorder for gases (IG). These are of two types; those with electric valve control (IG, Leuna) and those with mechanical valve control (IG Oppau). The measuring principle is based on the speed at which the gas goes through a narrow tube as compared to that of air through a similar tube. The recording delay is about two minutes and there is considerable interference if the gases are not pure.

8. Density recorder for gases. This is based on the principle of the lift on a glass sphere floating inside an upright glass tube through which the gas is passing. The recording is achieved through a magnetic coupling. It is used with almost all gases provided the base gas keeps its gaseous form at normal outside temperatures. It can also be used as an analysis recorder. These instruments are manufactured by Pollux, Ludwigshafen.

9. pH meter recorder

Measuring principle:

a. with standard antimony electrode directly on high resistance millivoltmeter

b. with glass electrode over compensation amplifier

It is used for measuring the ~~ion~~ hydrogen concentration in waste waters, for boiler feed water purification, for control in the production of catalysts, etc. These instruments are manufactured by IG Farben (for their own use) and by Hartmann & Braun (Frankfurt aM).

10. Concentration meter. These operate on the electric conductivity between two electrodes and with an alternating current bridge or photoelectric compensation apparatus to determine the current. They are used for the preparation of salt solutions, etc, and are manufactured by IG Farben (for their own use).

11. Titration instruments (for example, instruments for titrating sulphur trioxide). These instruments depend for their operation on the change of color produced as, for example, when sulphur trioxide comes in contact with glucose and iodine solution to give a blue color. The color change is then transmitted by a photocell to a recording apparatus. These instruments are manufactured by IG Farben (for their own use).

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ENCL. A.

12. Calorimeter (heat value recorder). The gas which is to be measured is burned underneath a calorimeter and the heat liberated is recorded by a thermo-battery submerged in water. The difference in temperature between the incoming and outgoing water determines the heat value of the gas. This instrument is used to determine the heat values of almost all combustible gases. It is manufactured by Junkers, Dessau.

VI Other Measuring Instruments and Regulators

The following measuring instruments are special instruments which are manufactured by IG Farben, Leuna, in small quantities only, and which may show certain differences in the individual pieces.

Dosing devices for liquids
Automatic analysers
Steam pressure recorders
Thrust recorders
Drop counter with photocell
Density meters with photocell (for liquids)

If desired, almost all measuring instruments can be remodeled as registering, recording, alarm, telerecording, or regulating instruments.

VII Comments on the Installation of Instruments

The most serious mistakes in the technology of measurements develop through faulty installation. Therefore, the directing engineer must be a well-experienced man in electric thermo-measuring installation, in order to handle short circuit of the measuring lines caused by moisture and/or acidic air; faulty contacts due to corrosion; contact resistance; defective switches; etc. He must also have enough experience with mechanical measuring instruments to be able to correct leaks in the measuring lines and valves; wrong placement of the sliding throttle valves; explosions due to unsuitable tubing material; faulty placement of the measuring lines in the use of quantity meters such as flow 1:10; wrong sealing; corrosion; etc.

ENCLOSURE (A)

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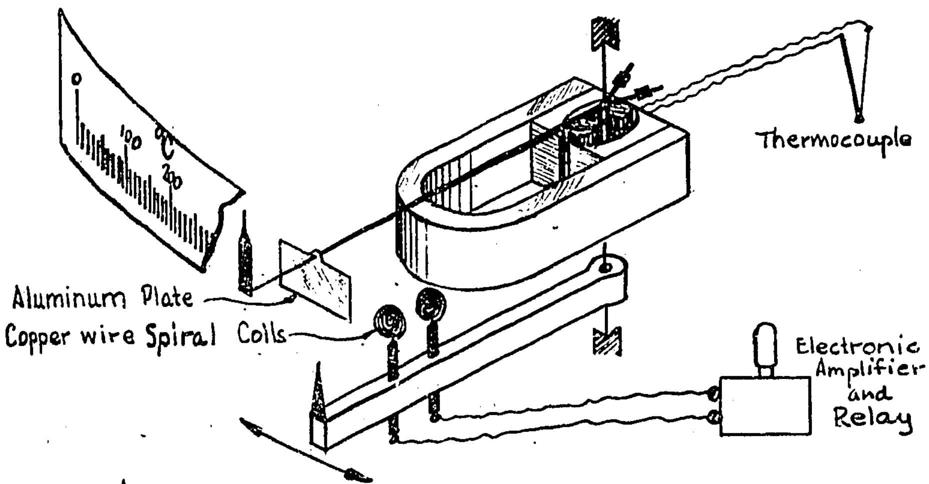
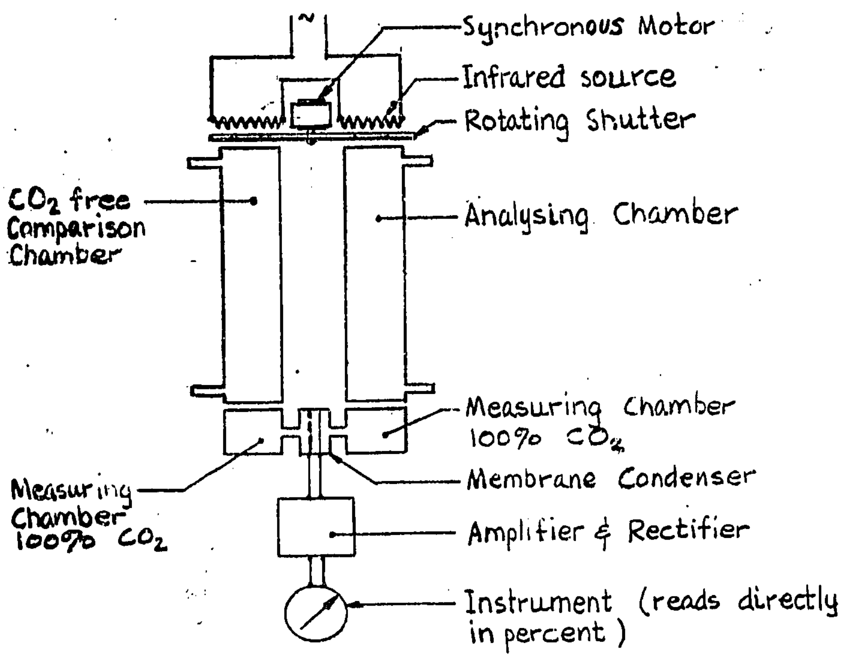
ENCL. C



SKETCH 1

Electronic Instrument for Chemical Analyses



SKETCH 2

An Infra-red Device for the Measurement of the Carbon Dioxide Content of a Gas

ENCLOSURE (C)

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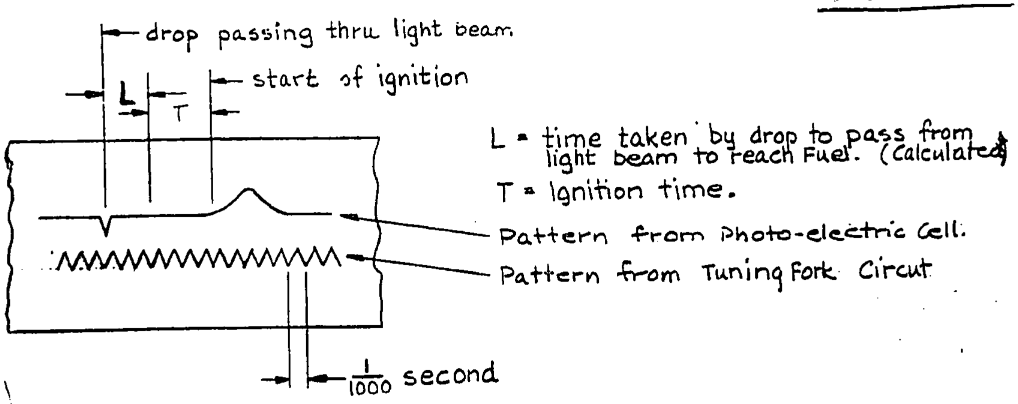
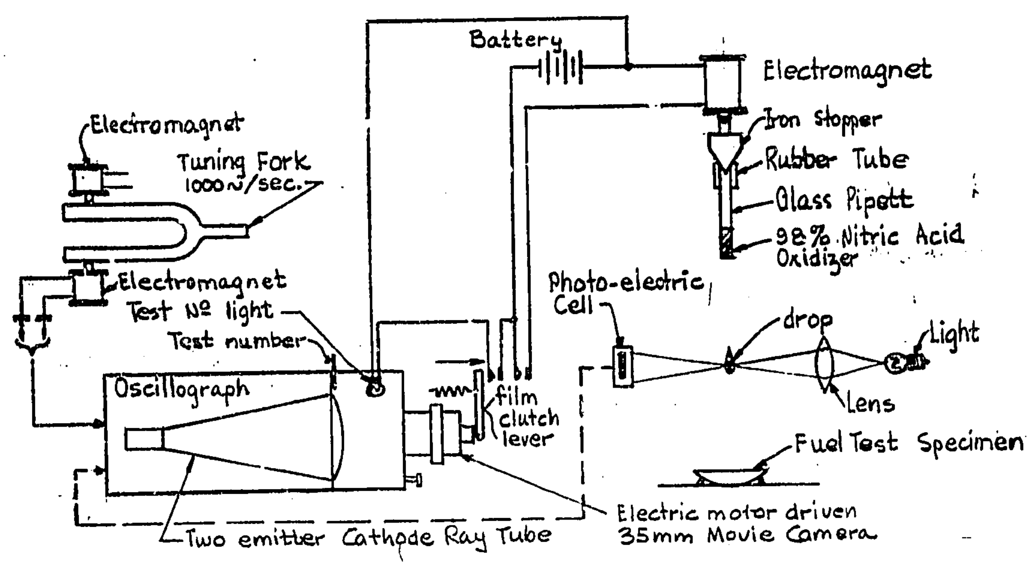
ENCL. D



Typical Film Pattern
(no scale)

Apparatus for Testing the Ignition Lag of Rocket Fuels



ENCLOSURE (D)

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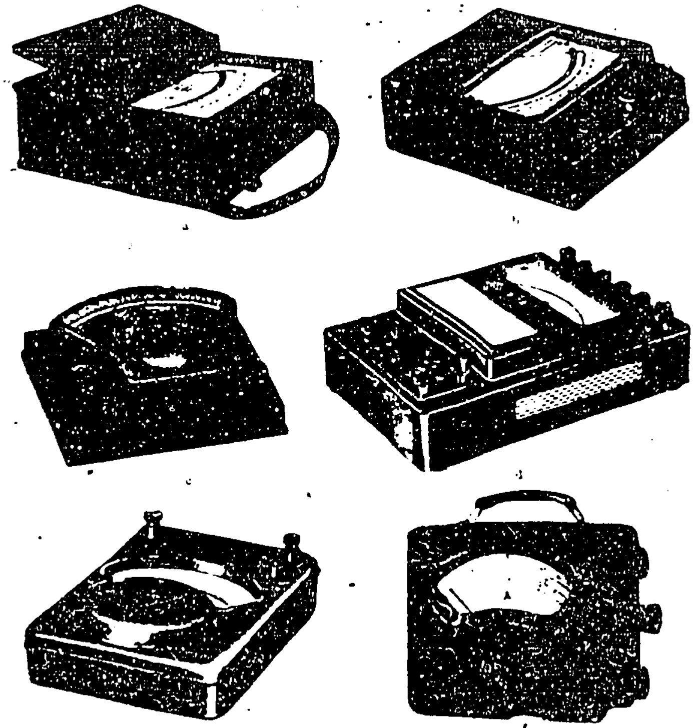

Abb. 20. Tragbare Geräte. a Holzgehäuse von H. & B. b Preßstoffgehäuse von H. & B. c Metallgehäuse von Weston. d Preßstoffgehäuse der AEG. e Preßstoffgehäuse von S. & H. f Montage-Instrument in Preßstoffgehäuse von S. & H.

Portable Apparatus with Metal, Wood, and Compressed Cases

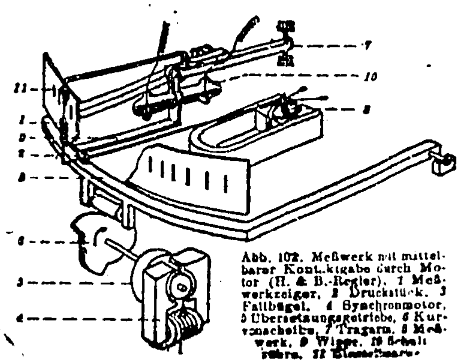

Abb. 102. Meßwerk mit mittelbarer Kontaktgabe durch Motor (H. & B.-Regler). 1 Meßwerkzeiger, 2 Druckstück, 3 Fallbügel, 4 Synchronmotor, 5 Übersetzungsgetriebe, 6 Kurvenscheibe, 7 Tragarm, 8 Meßwerk, 9 Wippe, 10 Schaltröhre, 11 [illegible]

Indirect Contact Control Apparatus

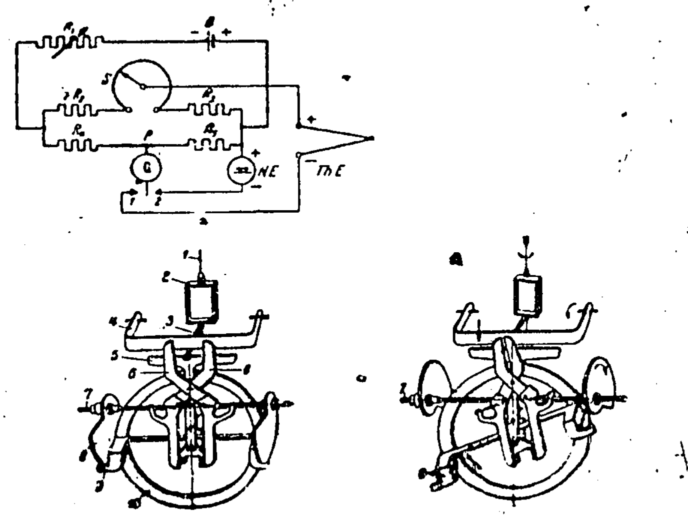

Abb. 105. Linienschreiber mit durch Motor bewegter Feder („Mikromax" von Leeds & Northrup). a Schaltung. Th.E. Thermoelement, N.E Normalelement, G Nullgalvanometer, B Batterie, R_1 Regelwiderstand, S Schleifdrahtspannungsteiler, R_2 u. R_3 Widerstände. b und c Mechanische Ausführung der Abgleichvorrichtung. 1 Spannfaden, 2 Drehspule, 3 Zeiger des Nullinstruments, 4 Fallbügel, 5 Gegenlage, 6 Abtasthebel, 7 Antriebswelle, 8 Kurvenscheiben, 9 Kupplungshebel, 10 Kupplungsrad, damit fest verbunden der [illegible] spannungsteiler S in a

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"Micromax" Line Recorder (Balancing Device)
Leeds & Northrup

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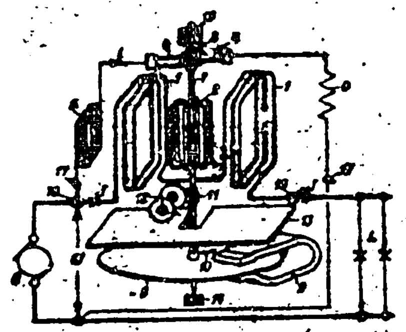

Abb. 116. Meßwerk und Schaltung eines dynamometrischen Zählers. [illegible]

Dÿnamic Counter

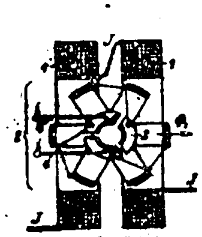

Abb. 117. Schnitt durch Anker und [illegible]

Dynamic Counter

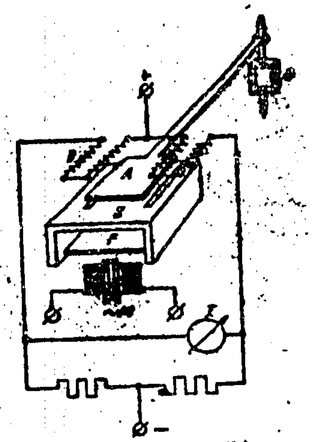

Abb. 171. Bolometerverstärker (ohne Kompensationsschaltung).

Bolometer Amplifier (without Compensation Switch)

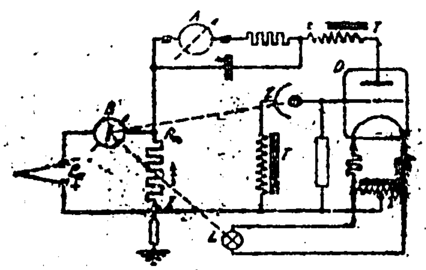

Abb. 170. Schaltung eines selbsttätigen Photozellenkompensators (H. & B.). T Transformator, E Photozelle, D Dreielektrodenröhre, L Lichtquelle, G Galvanometer, E_x Meßspannung, A Anzeigegerät.

Automatic Photocell Compensator Switch

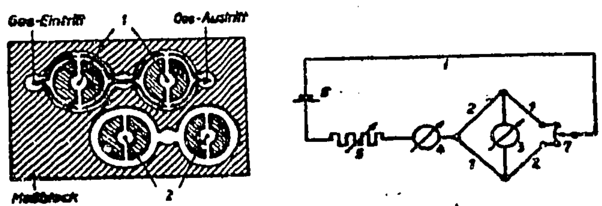

Abb. 232. Gaskonzentrationsmesser. a Meßblock mit 4 [illegible]kammern und Gasführung, 1 Meßdrähte, 2 Vergleichsdrähte, b Brückenschaltung, 1 und 2 Meß- bzw. Vergleichsdrähte, 3 Konzentrations-Anzeigegerät, 4 Strommesser, 5 Regelwiderstand, 6 Batterie für den Heizstrom, 7 Schleifdrahtwiderstand für Feinabgleichung.

Gas Concentration Measuring Equipment

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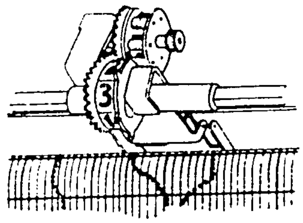

Abb. [illegible] Typenrad eines Kompensationsschreibers (Foxboro) für mehrere Meßstellen.

Foxboro Compensating Recorder
(Wheel Type)

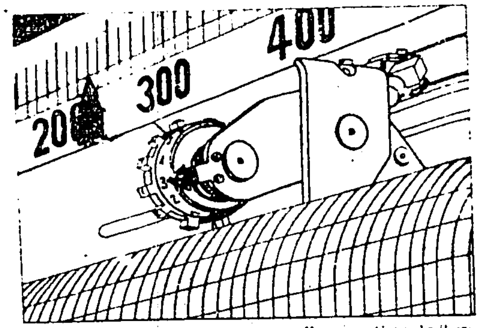

Abb. 14. Mehrfarb-Punktdrucker eines Kompensationsschreibers (Brown).

Multiple Color Dot-printing
Compensating Recorder (Brown)

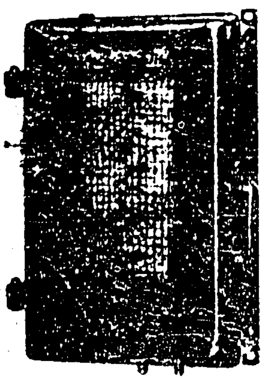

Abb. 75. Registrierender Druckmesser (H. & B.).

Pressure Recorder

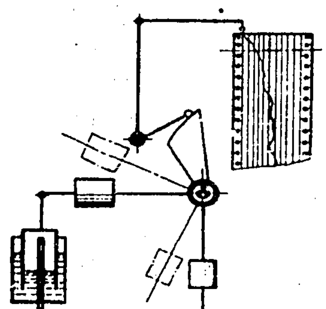

Abb. 76. Druckschreiber nach dem Tauchglockenprinzip, schematisch. (Debro-Werk.)

Pressure Recorder of
the Submerged Bell Type

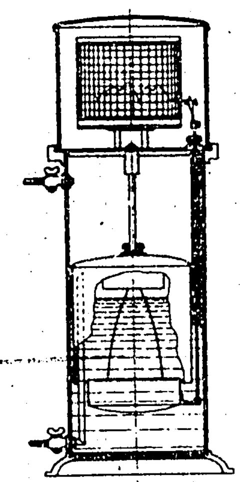

Abb. 85. Durchflußmesser. Tauchglockenprinzip (Debro).

Flowmeter (Submerged
Bell Type)

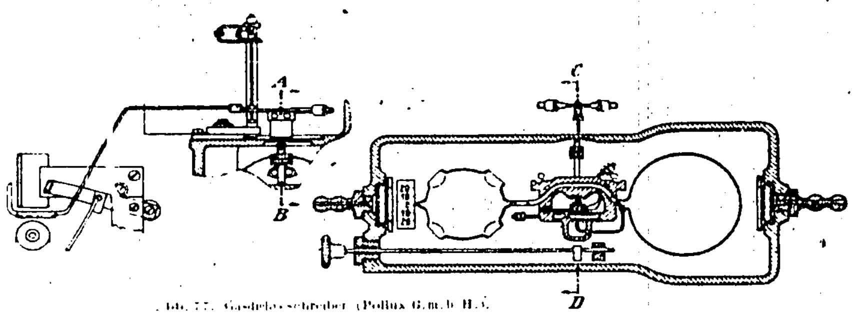

Abb. 77. Gasdichteschreiber (Pollux G.m.b.H.).

Gas Density Recorder

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Recording Ring Balance

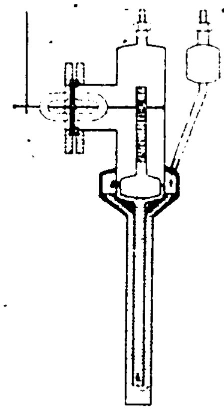
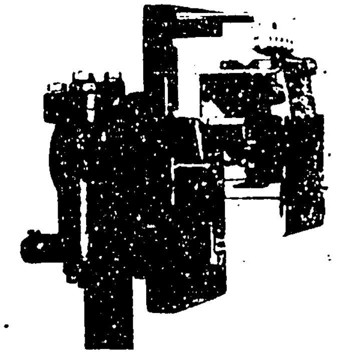


Abb. 88. Schwimmerdurchflußmesser mit magnetischer Kupplung. Schnitt.

Flowmeter (Float Type)



Recording Flowmeter (Float Type)

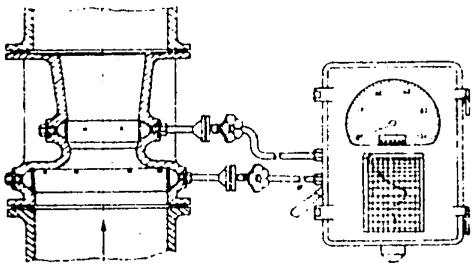
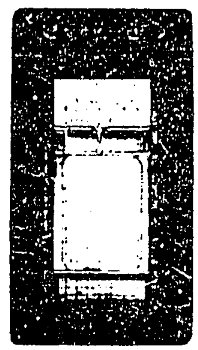
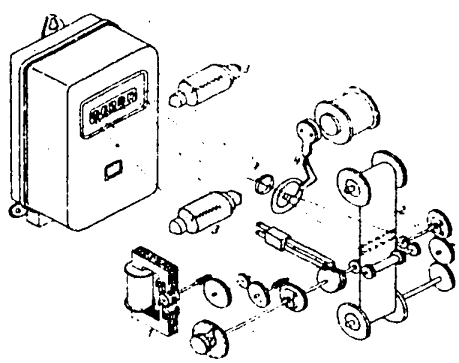


Abb. 90. Durchflußmesser mit Venturirohr (Bopp & Reuther).

Recording Flowmeter (Venturi Type)



Two-fold Pressure Recorder



Photographic Counter Recorder (Fotomax)

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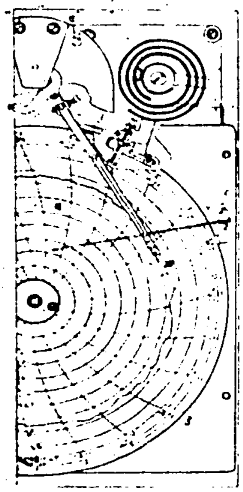

Abb. 94. Kreiskartenschreiber mit Rohrfedermeßwerk (Brown). 1 Meßwerk, 2 Hebelwerk, [illegible] Kreisblatt

Circular Chart Recorder with Pen

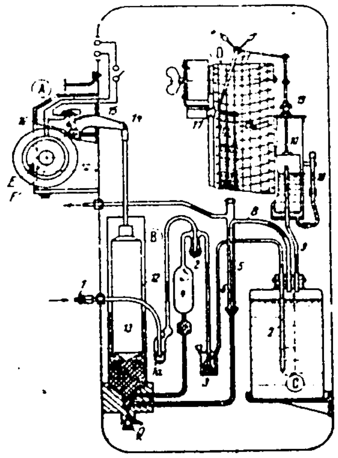

Abb. 106. Aufbau des Mono-CO_2-Schreibers (Maihak). Schema. A Elektrischer Antrieb, B Gaspumpe, C Absorptionsgefäß, D Registrierwerk, E Ölfüllschraube für Getriebekasten, F Motor, Q Quecksilberfüllschraube, 1 Gaseintritt, 1a Wasservorlage, 2 Saugsperre, 3 Drucksperre, 4 Volummeter, 5 Absperrohr, 6, 7, 8, 9 Rohre, 10 Meßglocke, 11 Schreibhebel, 12 Zylinder, 13 Tauchkolben, 14 Antriebshebel, 15 Schalthebel, 16 Quecksilberschalter, 17 Tintenvorratsbehälter, 18 Schaurohr, 19 Führungsmutter.

CO_2 Recorder (Diagramatic)

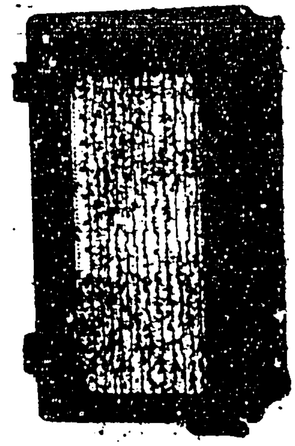

Abb. 128. Elektromagnetischer Zeitschreiber (H. & B.).

Electromagnetic Time Recorder

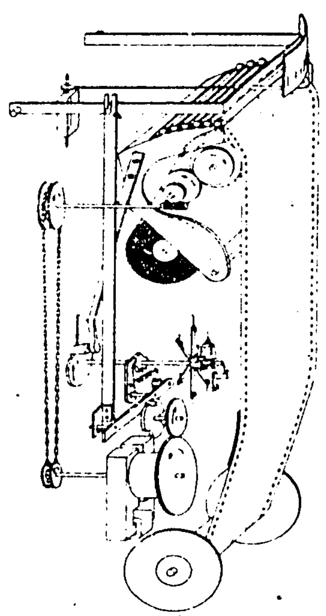

Abb. 123. Sechsfarbenschreiber (H. & B.) schematisch.

Six-color Recorder (Schematic)

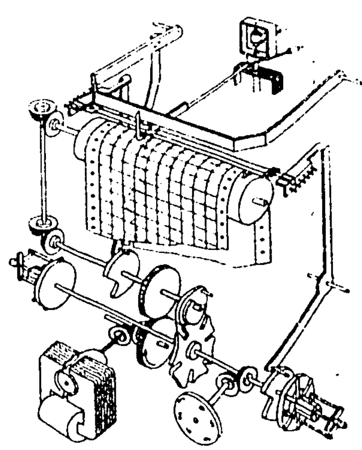

Abb. 124. Sechsfarbenschreiber (AEG) schematisch.

Six-color Recorder (Schematic)

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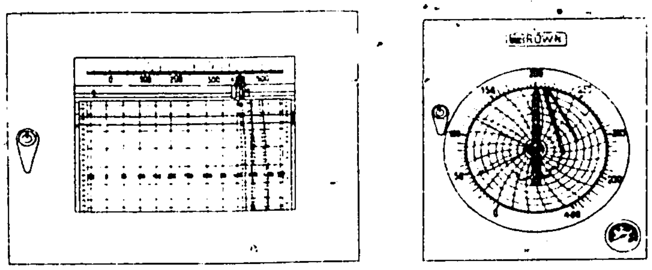

a b

Abb. 149. Kompensographen von Brown mit Brückenschaltung a mit ablaufendem Streifen, b mit Kreisblatt.

Compensating Graph (Brown Type) a. Moving Band Type
b. Circular Type

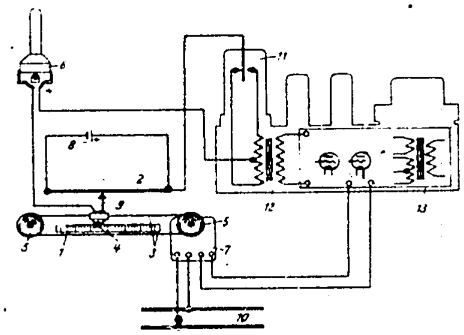

Abb. 150. Schaltung der Kompensographen nach Abb. 149. 1 Skala, 2 Schleifdrahtwiderstand, 3 Drahtseil, 4 Zeiger, 5 Rollen, 6 Thermoelement, 7 Motor, 8 Batterie, 9 Schleifer, 10 Wechselstromnetz, 11 Wechselrichter, 12 Transformator, 13 Verstärker.

Wiring Diagram of the Above Compensating Graph

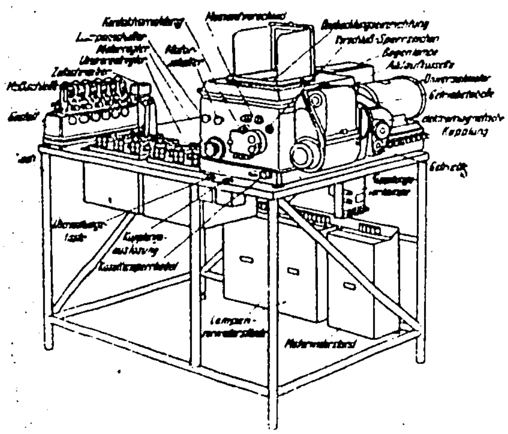

Abb. 164. Sechsschleifen-Oszillograph S & H.

Six-band Optical Oscillograph

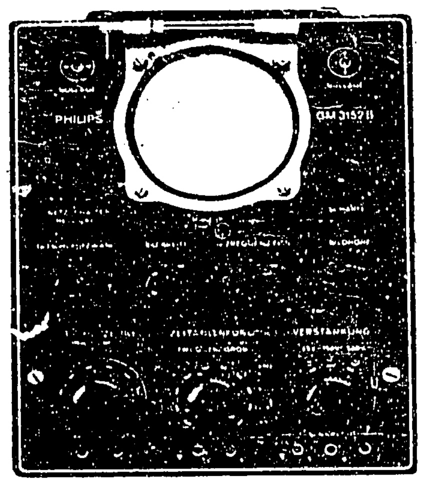

Abb. 170. Tragbarer Kathodenstrahl-Oszillograph (Philips, [illegible] mm Ø)

Portable Cathode Ray Oscillograph
(German Phillips)

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